Q: It is possible to convert mass into energy, but can we do the reverse? (Hardeepsingh, Derabassi, Punjab, India)

A: Yes, we routinely make mass from kinetic (moving) energy generated when particles collide at the near-light speeds attained in particle accelerators. Some of the energy changes into mass in the form of subatomic particles, such as electrons and positrons, muons and anti-muons or protons and anti-protons. The particles always occur in matter and anti-matter pairs, which can present a problem because matter and anti-matter mutually destruct, and convert back to energy.

"Most of the time, though, they don't meet and annihilate, since they are flying apart so fast," says physicist Erik Ramberg of Fermilab. At all points in the basic vacuum of space-time, we think these pairs wink into and out of existence, spontaneously, "without being observed."

Even more exotic: black holes convert energy into matter. Near the surface of a black hole, matter-antimatter particle pairs apparently pop into existence; then one particle falls into the hole, while the other escapes. "This makes a black hole 'shine' with fundamental particles," says Ramberg. Steven Hawking first predicted the phenomenon, which we have not yet verified experimentally.

Using magnetic fields, though, we have managed to trap a small amount of anti-matter. Indeed, in 1995, scientists at the CERN accelerator in Switzerland made nine anti-hydrogen atoms. How long would it take to make three grams (the mass of a penny) of anti-hydrogen? CERN makes about ten million anti-protons in a second. If CERN could keep generating anti-protons at that rate non-stop, they could make three grams in about six billion years. Fermilab could do the job in a tenth the time, since they make 100 million anti-protons per second. Still, six hundred million years is a long time to make three grams of mass.

Thus, we don't make much mass in particle accelerators, because it takes too much energy. The lights of Chicago may not actually dim when they run the Chicago's big accelerator at Fermilab, but the accelerator is a "significant drain" on the electricity grid, says Koji Mukai of NASA'S Goddard's Space Center. Consider how much energy is in a kilogram (2.2 lbs) of water. If we could convert that mass into the equivalent energy, we'd have enough energy to drive a car for about 100,000 years without stopping, say CERN scientists.

Einstein showed us, with his deceptively simple equation (energy = mass times the speed of light, squared), that mass is simply another form of energy. We can, and do, go both ways: mass to energy and energy to mass. But we don't make much mass.

(April Holladay, USA Today)